to form a first ion implantation region in said dielectric layer;

a second ion implantation process with a second energy between 350 to 700 KeV to form a second ion implantation region in said first ion implantation region of said dielectric layer; and

a third ion implantation process with a third energy between 1 to 3 MeV.

55. (Amended□The method according to claim 54, wherein said first ion implantation process comprises a first ion with dosage about 10^{12} to 10^{15} /cm^2.

58. (Amended) The method according to claim 54, wherein said second ion implantation process comprises a second ion with dosage about 10^{12} to 10^{15} /cm^2.

60. (Amended) The method according to claim 54, wherein said third ion implantation process comprises a third ion with dosage about 10^{12} to 10^{14} /cm^2.

62. (Amended) The method according to claim 51, wherein the etching selectivity between said dense region and said dielectric layer is about 2.

REMARKS

Reconsideration of the application is respectfully requested in view of the following reasons. Entry of this Amendment Under Rule 1.116 is merited as it raises no new issues and requires no further search.

The Examiner states that claims 55, 58 and 60 are objected to for informalities and claims 51, 53, 54 and 62 are rejected under 35 U.S.C. 112. In response thereto, claims 51, 53, 54, 55, 58, 60 and 62 that are objected and rejected in the Official Action now comply with the Examiner's requirements. However, claims 51, 53, 54, 55, 58, 60 and 62 are amended in order to present a better and proper form

and are supported by the specification and figures. The original Figures and the original specification as originally filed support all amendments of claims 51, 53, 54, 55, 58, 60 and 62. It is respectfully submitted that these changes are clearly supported by the description of the application, and therefore do not constitute new matter. Therefore, it is believed that claims 51 to 63 should be in immediate condition for allowance.

Rejection of Claims 51, 53, 54 and 62 Under 35 U.S.C. §112, Second Paragraph

Claims 51, 53, 54 and 62 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

According to the Final Office Action, the Examiner states that the claim 51 recitation of a "certain thickness" is indefinite; and further, the Examiner states that in claims 53 and 54 "energy substantially between" is indefinite and vague; and further, the Examiner states that in claim 62 "the etched selectivity" lacks antecedent basis for the limitation in the claim. Applicant has amended claim 51 by deletion of "certain", and claims 53 and 54 by deletion of "substantially", and claim 62 by replacing "etched" with "etching". In claims 51, 53, 54 and 62, the recitations as the Examiner stated in the offices action have been corrected to comply with the Examiner's requirements. Thus, it is respectfully submitted that amended claims 51, 53, 54 and 62 are in condition for allowance and reconsideration and withdrawal of the rejections under 35 U.S.C. §112 is respectfully requested.

Rejection of Claims 51 and 63 Under 35U.S.C. §102 (e)

Claim 51 stands rejected under 35 U.S.C. §102 (e) as being anticipated by Chen et al. (U.S. Patent, No. 6,080,663) ; and further, claims 51 and 63 stand

rejected under 35 U.S.C. §102 (e) as being anticipated by Jeng et al. (U.S. Patent, No. 6,372,660) .

This rejection is respectfully traversed on the basis that Chen and Jeng do not disclose the features of the present invention. Chen discloses a method for forming the dual damascene by an ion implantation. In the citation of Chen, the ion implantation 210 is performed to form a doped region 212 in the predetermined position for forming the dual damascene opening, wherein the doped region 212 has an etching rate different from the other part of the dielectric layer 204 (col.3, lines 44-48) . However, it is noted that the etching rate of the doped region 212 must be larger than that of the other part of the dielectric layer 204, otherwise the dual damascene opening cannot be formed (FIG.2B to FIG.2D) . On the contrary, in the present invention, the etching rate of the doped regions 440/540 must be lower than that of the other part of the dielectric layers 450/410 and 510, as shown in FIG. 4B-4C and FIG. 5B-5C. On the other hand, in the citations of Chen and Jeng, the first photoresist layer is used to form the via region, and the second photoresist layer is used to form the trench and the via hole, but the present invention utilizes the first photoresist layer to form the trench region and the second photoresist layer to form the via hole and the trench. Therefore, the principle as described by Chen is different from the present invention.

Furthermore, Jeng also discloses a method for forming the dual damascene with a masked implantation. In the citation of Jeng, the masked implantation 530/630 is performed to form the dense regions 540/640 as the etched barrier layers that are maybe the etched stop layers (col.5, lines 30-34; and col.5, lines 63-65) , because the etching process is finished until exposing the surface of the dense regions 540/640, as shown in FIGs.5B-5C and FIGs.6B-6C in the citation of Jeng. In other words, the dense regions 540/640 cannot be removed during the etching process to form the opening of the dual damascene as taught by Jeng. On the contrary, the doped region in

the present invention has to be removed after finishing the etching process. If the dense regions 540/640 in the citation of Jeng are removed, the dielectric layers 510/610 will be lost during the etching process, and then the dual damascene opening can not be formed. Therefore, the citation of Jeng is different from the present invention.

For the foregoing reasons, it is believed that the accumulation of elements from cited sources in such diverse art is insufficient to present a prima facie case of obviousness. There is no reason, suggestion, or motivation in the cited prior art, whereby a person of ordinary skill would modify Chen or Jeng by any citation to perform the process of the present invention. For these reasons, and for the reasons discussed above, it is respectfully submitted that Chen and Jeng do not anticipate claims 51 and 63 of the present invention and withdrawal of the rejection under 35 U.S.C. §102 (e) is respectfully requested.

Rejection of Claims 52-62 Under 35U.S.C. §103 (a)

Claim 52 stands rejected under 35 U.S.C. §103 (a) as obvious over Jeng in view of Muller (U.S. Patent, No. 6, 207, 517) ; and further, claims 53-62 are rejected under 35 U.S.C. §103 (a) as being unpatentable over Jeng and Muller as applied to claims 51-52 above and further in view of Wu (U.S. Patent, No. 6, 127, 247) .

This rejection is respectfully traversed on the basis that there is no teaching, suggestion, or incentive supporting the citation, predominantly because the cited references disclose the method for forming a dual damascene different from the present invention. The method for forming the dense region, or implanting process, or the opening of the dual damascene formed by ion-implantation two times are not the features of the present invention. The features of the present invention disclose formation of a dense region with a lower etching rate in the dielectric layer in order to protect the dielectric layer under the dense region from the etching process, so as to

form an opening of the dual damascene after etching the vertical that is not dense. That has not been shown in all citations.

In the Muller reference, various ion-implantation and depths are utilized to form dual implanting region, as shown in FIG.1b, and then an etching process is performed to remove the region with high etching rate that is implanted to form dual damascene, as shown in FIG.1C. On the contrary, the present invention utilizes ion-implantation to form a dense region with lower etching rate to generate a greater etched selectivity between implanting and un-implanting regions in a dielectric layer, so as to remove the un-implanting region with low etching rate until the implanting region is depleted during the etching process, that is, the implanting region of the present invention is an etched stop layer or an etched buffer layer, whereby an opening of the dual damascene is formed. Obviously, the dual damascene structure with a dense region and a non-dense region in the present invention is different from the dual damascene structure with two implanted regions taught by the applied references. Specifically, these references fail to disclose that the opening of the dual damascene is formed by the buffer layer of the ion-dense region.

Moreover, claims 52 to 63 depend from claim 51, and claims 52 to 63 are allowable for at least the reasons advanced above with respect to claims 51. Withdrawal of the rejection of claims 52 and 63 is respectfully requested, and allowance of claims 52 to 63 is earnestly solicited.

According to the cited references and figures thereof, the purpose disclosed in the present invention is not achieved or accomplished by combining the processes of the cited references from each other. Moreover, it has been held that a rejection "suggest[ing a] combination of references [which] would require a substantial reconstruction and redesign of the elements shown in the primary reference as well as a change in the basic principle under which the primary reference construction was designed to operate" should be reversed. 123 USPQ at 352. Hence, the difference

between the cited references and the present invention is non-obvious. The citations do not disclose or suggest the purpose and features of this invention. In view of the foregoing, the features of the present invention are patentably distinguishable from the cited references. It is respectfully submitted that one of ordinary skill in the art could only have used hindsight to make the proposed modification. A rejection, which ignores the purposes of the prior art in the manner that an ordinary artisan would have perceived them, is not proper, as explained in MPEP 2143.01. Furthermore, a prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983) , 469 U.S. 851 (1984) .

Therefore, for these reasons and the reasons discussed above, applicant respectfully submits that claims 52 to 63 of the present invention are patentably distinguishable from the cited references. Withdrawal of this rejection under 35 U.S.C. §103 (a) is respectfully requested, and allowance of claims 52 to 63 is earnestly solicited.

Conclusion

In light of the above amendments and remarks, applicant respectfully submits that all pending claims 51 to 63 as currently presented are in condition for allowance and hereby respectfully requests reconsideration. Applicant respectfully requests the Examiner to pass the case to issue at the earliest convenience. Having thus overcome

each of the rejections made in this Office Action, withdrawal of the rejections and expedited passage of the application to issue is requested.

Respectfully submitted,

LOWE HAUPTMAN GILMAN & BERNER LLP

Randy A. Noranbrock
Registration No. 42,940

Date: October 17, 2002
USPTO Customer No. 22429
1700 Diagonal Road, Suite 310
Alexandria, Virginia 22314
(703) 684-1111
(703) 518-5499 Facsimile

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend claims 51, 53, 54, 55, 58, 60 and 62 as follows:

51.(amended) A method for forming a dual damascene opening, comprising:

providing a substrate with a dielectric layer [in a certain thickness] thereon;

providing a first patterned photoresist on said dielectric layer to expose a portion of said dielectric layer at which at least a portion of trench is to be formed;

implanting ions into said exposed dielectric layer in a depth of part of the thickness under the masking of said first patterned photoresist so as to form a dense region having an etching rate lower than that of said dielectric layer;

removing said first patterned photoresist;

providing a second patterned photoresist on said dielectric layer, said second patterned photoresist defining an etching opening for exposing at least part of said dense region and a region of said dielectric layer in which a via hole is to be formed;

etching said exposed dielectric layer and said dense region simultaneously under the masking of said second patterned photoresist until a portion of said substrate is exposed; and

removing said second patterned photoresist.

53.(amended) The method according to claim 52, wherein said retrograde implantation comprises:

a first ion implantation process with a first energy [substantially] between 20

to 100 KeV to form a first ion implantation region in said dielectric layer; and

a second ion implantation process with a second energy [substantially] between 350 to 700 KeV.

54. (amended) The method according to claim 52, wherein said retrograde implantation comprises:

a first ion implantation process with a first energy [substantially] between 20 to 100 KeV to form a first ion implantation region in said dielectric layer;

a second ion implantation process with a second energy [substantially] between 350 to 700 KeV to form a second ion implantation region in said first ion implantation region of said dielectric layer; and

a third ion implantation process with a third energy [substantially] between 1 to 3 MeV.

55.(amended) The method according to claim 54, wherein said first ion implantation process comprises a first ion with dosage about 10^{12} to 10^{15} /cm^2.

58.(amended) The method according to claim 54, wherein said second ion implantation process comprises a second ion with dosage about 10^{12} to 10^{15} /cm^2.

60.(amended) The method according to claim 54, wherein said third ion implantation process comprises a third ion with dosage about 10^{12} to 10^{14} /cm^2.

62.(amended) The method according to claim 51, wherein the [etched] etching selectivity between said dense region and said dielectric layer is about 2.